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AUTHOR Blank, Rolf K.
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ABSTRACT

The Council of Chief State School Officers is in the process of assessing reforms that are aimed at improving science and mathematics education at the elementary and secondary levels. This document provides tabulations of the number of states that currently collect data on various indicators of science and mathematics education. Six categories of indicators were included in this inventory. These were: (1) student outcomes; (2) instructional time/enrollment; (3) curriculum content; (4) school conditions; (5) teacher quality; and (6) resources. The results of the survey indicated that a majority of the states have programs of student achievement testing in science or mathematics. In contrast, only seven states collect information on student attitudes/intention towards further education in science or mathematics, and fewer than ten states collect data on minutes per week actually spent on elementary science and mathematics. (TW)

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Council of Chief State School Officers
State Education Assessment Center

Science and Mathematics Indicators Project

RESULTS OF AN INVENTORY OF STATE INDICATORS AND DATA ON SCIENCE AND MATHEMATICS EDUCATION*

* The document provides tabulations of the number of states that currently collect data on various indicators of science and mathematics education. Six categories of indicators are included: Student Outcomes, Instructional Time, Curriculum Content, Teacher Quality, and Resources. The document also shows tabulations of the number of states interested in having the indicators available, and state policies and guidelines related to science and mathematics education.

Prepared by:
Rolf K. Blank, Project Director
Council of Chief State School Officers
400 North Capitol Street
Washington, D.C. 20001
(202) 624-7700

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STATE SCIENCE AND MATHEMATICS INDICATORS PROJECT
Progress Report, November, 1987

Many states have instituted reforms that are aimed at improving science and mathematics education in elementary and secondary schools. Standards for teacher certification have been raised, curricula have been revised, course requirements for graduation have been increased, and incentives have been provided for attracting and retaining teachers in science and mathematics. The Council of Chief State School Officers is providing leadership in improving states' capacity for assessing the effects of the reforms through a three-year project to develop and improve state-level indicators and data on science and mathematics education. The project, which began in October, 1986, is being supported by the National Science Foundation.

There are two major goals for the project: 1) to improve the quality and usefulness of data on science and mathematics education to assist state policy-makers and program managers in making more informed decisions, and 2) to develop a system of indicators that provides the capacity for state-to-state comparisons of science and mathematics education as well as a national database to assess the condition of education in these subjects.

In the project's first year, states reported on their current policies, indicators, and data related to science and mathematics education. A survey was conducted through a 50-state network of curriculum, assessment, and information systems specialists. The survey covered six types of indicators: Student Outcomes, Instructional Time/Enrollment, Curriculum Content, School Conditions, Teacher Quality, and Resources. The survey was developed from recommendations on educational indicators from several recent studies, including the National Academy of Sciences, The Rand Corporation, and the Council of Chief State School Officers. Some of the findings of the survey were that:

- More than forty states have programs of student achievement testing in science or mathematics.
- Thirty-four states collect secondary student enrollment by course, most often through teacher assignment information.
- Twenty-five states provide direction or guidance on elementary class time to be spent on science and mathematics.
- Thirty-one states develop estimates of teacher shortages or supply and demand.

In contrast, only seven states collect information on student attitudes/intentions toward further education in science/mathematics, and fewer than ten states collect data on minutes per week actually spent on elementary science and mathematics. The complete results of the survey in all the states are tabulated in this report.

In the second year, the focus of the project is on planning for a small number of key state-by-state indicators of science and mathematics education. To begin this process, the results of the inventory were analyzed by a task force comprised of state science and mathematics specialists, state data managers, and experts on educational indicators. Three criteria for selecting indicators were used: a) importance/usefulness of the indicator at state, local, and national

levels; b) technical quality of the data; and c) feasibility of obtaining state-by-state data.

A set of recommendations for proceeding with the development of state indicators was submitted to the chief state school officers, and they were approved in November. The recommendations identify indicators for which the project should give high priority in obtaining comparable state data and strategies for developing the state-level indicators.

- One group of indicators would be developed from existing state data systems. These indicators would include secondary course enrollment in science and mathematics, teacher assignment, and teacher field of certification.

- A second group of indicators would be obtained through existing national surveys that have state representative data. The proposed state-by-state National Assessment of Educational Progress could provide science/mathematics indicators of student achievement, student attitudes/intentions, and "opportunity- to-learn" key content topics tested in science and mathematics. Other priority indicators such as teacher preparation in science/mathematics, school conditions, and elementary class time could be obtained through the new Schools and Staffing Survey of the Center for Education Statistics.

- To allow analyses of equity in science and mathematics education, the indicators should include data on student race/ethnicity and gender.

Over the next six months, the project will work with representatives of the states, in groups and individually, to arrive at a state-by-state plan for producing comparable data on the priority indicators. State specialists will meet to design a plan for reporting state data through a common format that allows state-by-state comparisons. Then, through a series of regional workshops, state representatives will review the draft plan and discuss how each state could meet the specifications of the plan. By the end of the second year of the project, the goal is to have a system designed for obtaining comparable state data on the priority indicators and to have plans completed with each state on how data can be provided.

In the third year of the project, beginning in the fall of 1988, activities will focus on assisting states with implementation of the priority indicators plan. Each state has laws, policies, and priorities as well as data and reporting systems which affect its capacity to report data according to a state-by-state indicators system. Thus, the questions and problems that states have in reporting data according to the specifications for state-by-state indicators will need to be addressed and resolved. The project staff will coordinate the initial reporting and collection of data on the science and mathematics indicators and the information will become a part of CCSSO's annual report on state-by-state education indicators.

Three project reports are available at this time: 1) Results of the Inventory of State Indicators of Science/Math Education; 2) State Policies Related to Science & Mathematics Education; and 3) Recommendations on Developing Science/Math Indicators with the States. Each report can be obtained for $2.00 by writing to: Rolf Blank, Director, Science/Math Indicators Project, Council of Chief State School Officers, 400 N. Capitol Street, Washington, D.C. 20001.

INVENTORY OF
STATE INDICATORS AND DATA ON SCIENCE
AND MATHEMATICS EDUCATION
First Stage Results (August, 1987)

STUDENT OUTCOMES INDICATORS

Student Achievement: State Testing	Number of States				(N=54)
	Subject*		Required for Graduation		
Competency test	Science	7	Science	1	
	Math	34	Math	18	
Assessment test	Science	28	Science	1	
	Math	35	Math	1	
Course-specific tests	Science	4	Science	1	
	Math	4	Math	1	

Student Attitudes	Number of States		(N=54)
	Current Data Collection	Interested** in Indicator	
Towards science/math subject matter	7	29	
Towards teachers	3	26	
Towards further study	4	32	

Postsecondary Education		
Science/Math majors by high school	8	23
Science/Math majors by race/ethnicity and sex	7	26
High school seniors intend to major in science or math in college	13	22
Postsecondary remedial courses in science/math	5	20

Careers and Science/Math Education		
High school graduates entering occupations requiring science or math	2	29

* State testing conducted in one or more grades.
** Data not currently collected but state interested in having data/indicator available.
(N=54) 50 states, District of Columbia, Guam, Puerto Rico, Virgin Islands

INSTRUCTIONAL TIME INDICATORS

	Number of States		(N=54)
	Current Data Collection	Interested in Indicator	
Elementary Class Time			
Local districts with requirements for class time on:			
Science	14	17	
Mathematics	12	17	
Minutes per week actually spent on science/math	11	33	
By ability level of classes	1	23	
By proportion minority students	1	23	
Secondary Enrollment			
Grade 9-12 students enrolled in science/math	36	15	
Students enrolled in specific science/math courses	33	15	
Student enrollment by race/ethnicity and sex	10	28	
Homework			
Districts with policies on homework	12	16	
Time on science/math homework in grades	1	17	
Time on homework in specific science/math courses	2	17	

CURRICULUM CONTENT INDICATORS

States with curriculum framework or curriculum standards	Number of States Currently	Planning	(N=54)
Science	38	4	
Mathematics	38	4	
States with curriculum guide only (no framework or standards)			
Science	6	2	
Mathematics	7	0	

Purpose of state framework or standards	Number of States by Subject
Required curriculum	15 science and math 1 math only
Curriculum goals	25 science and math
Instructional objectives	16 science and math 7 math only
Advice and assistance	23 science and math 2 math only

Uses of curriculum framework (or guide) at state level	Current Use	Interested in Indicator
Select or recommend textbooks		
Science	25	1
Mathematics	26	1
Develop state test(s)		
Science	19	6
Mathematics	26	4
Select test(s) for statewide use		
Science	11	7
Mathematics	18	7

CURRICULUM CONTENT INDICATORS (Continued)

Information on local curriculum content	Number of States (N=54)		
	Current Data Collection	Planning	Interested in Indicator
Review of district curriculum			
Science	8	7	13
Mathematics	10	6	9
Review of school subject/course outline/curriculum			
Science	10	3	7
Mathematics	11	3	7
Survey of teachers for self-reports on content of instruction			
Science	8	2	8
Mathematics	9	2	7
Classroom observation of teachers			
Science	9	2	7
Mathematics	9	2	7
Review of locally-selected textbooks			
Science	8	1	4
Mathematics	9	1	4
Review of locally-selected tests			
Science	2	1	8
Mathematics	3	1	7
Opportunity-to-learn questions with state testing			
Science	9	1	8
Mathematics	12	4	9

SCHOOL CONDITIONS INDICATORS

Work Load of Teachers	Number of States: Current Data Collection	Number of States: Interested in Indicator	(N=54)
Class Size			
Elementary	22	10	
Middle/Junior	24	11	
High school courses	29	13	
Number of classes per teacher	32	14	
Number of different preparations per teacher	25	15	
Teacher aides per science and mathematics teacher	7	17	
By school	9	11	
Elementary science/math specialist teachers	18	20	
By school	15	16	
Schools with science or math theme or curriculum concentration	13	18	
Teacher perceptions/attitudes:			
Adequacy of administrative support	4	20	
Participation in schoolwide decisions	3	20	
Professional autonomy in teaching	3	22	
Availability of resources	5	23	
Opportunities to develop professional knowledge and skills	3	25	

TEACHER QUALITY INDICATORS

	Number of States		(N=54)
Demographic Data on Teachers	Current Data Collection	Interested in Indicator	
School district code	51	2	
School code	51	2	
Date of birth (age)	47	2	
Sex	50	1	
Racial/ethnic group	38	3	
Education/Preparation in Teaching Subject			
Education level (degree status)	48	2	
Academic major (bachelors degree)	43	5	
Number of courses/credits in science/ mathematics	29	9	
Course titles (from transcript)	30	5	
Subject of teaching assignment	49	3	
Courses comprising teaching assignment	40	5	
Certification status (e.g., regular vs. emergency)	51	2	
Field(s)/subject(s) of certification	50	2	
Course endorsements	39	1	
Teaching Experience			
Total years	48	3	
Years in current district	36	4	
Years in other district(s)	23	4	
Years in current assignment	13	11	
Teacher Data on Automated File	47		

TEACHER QUALITY INDICATORS (Continued)

New Hires	Current Data Collection	Planning	Interested in Indicator
Occupation prior year	10	2	8
Location of occupation prior year	7	1	8
Science/math teachers status after two years	14	5	25
Transfers to other schools/districts	14	2	10
Observation of Teaching Performance			
Using state standards	5	2	11
Using local standards	0	2	8
Professional Development			
Hours per year in inservice or staff development	11	3	24
Types of inservice or staff development programs or activities of science and math teachers	12	3	23
Continuing education courses/ credits in field of assignment	9	6	20
Year of last course/credits	13	5	14
Time per year in voluntary professional development (e.g., meetings, workshops)	2	2	20

TEACHER QUALITY INDICATORS (Continued)

Teacher Subject Knowledge	Number of States	(N=54)
State testing of subject knowledge	24	
Use of subject knowledge tests	Currently Use	Interested
For certification	21	12
For recertification or renewal	1	11
For testing random sample of teachers	0	14

Teacher Shortage or Supply/Demand		
State estimates made of teacher shortage or supply and demand	Number of States	(N=54)
	31	
Types of Data Collected	Current Data Collection	Interested in Indicator
Supply of Teachers:		
New college graduates in education	33	9
Graduates with non-education majors	20	13
Entrants from other occupations	17	14
Re-entrants into teaching	21	14
Current teachers in new field	19	16
In-migration of teachers into state	27	14
Continuing teachers with regular or standard certification	31	9
Demand for Teachers:		
Pupil-teacher ratio	37	7
Pupil-teacher ratio by subject/field	22	12
Enrollment projections	36	6
Teachers retiring	37	10
Teacher attrition	32	10
Emergency/provisional certificates	39	8
Positions vacant, filled with out-of-field teacher or substitute, or withdrawn	31	14

RESOURCES INDICATORS

Teacher Pay	Number of States (N=54)	
	Current Data Collection	Interested in Indicator
Annual teacher salary	47	1
Salary of college graduates in state by academic major	11	14
Ratio of teacher salary to non-teacher salary with same major	9	16
Classroom Resources Available		
Equipment	15	21
Textbooks	16	20
Laboratory facilities	16	21
By schools with inadequate resources	10	20

Expenditures for Science/Math	Current Data	Planning	Interested in Indicator
State expenditures for science and mathematics	7	3	22
Local expenditures for science and mathematics	6	2	20

STATE POLICIES AND GUIDELINES

Policy or Guideline Related to Science or Mathematics	Number of States (N=54)
Elementary class time to be spent on science or mathematics	22 science and math 3 math only; 1 science only
Teacher workload in science or mathematics	8 science and math 1 science only; 1 math only
Use of elementary subject specialists	3 science and math
Textbook selection (recommended or required)	27 science and math 1 math only
Incentives for attracting or retaining science or math teachers	23 science and math 2 science only
Availability of classroom resources (equipment, laboratories, materials)	18 science and math 7 science only

High School Graduation Requirements		Number of States (N=54)
Regular diploma		
Mathematics:	2 courses	33
	3 courses	10
	Other*	11
Science:	1 course	7
	2 courses	34
	3 courses	4
	Other**	9
Advanced diploma		
Mathematics:	2 courses	1
	3 courses	8
	4 courses	3
Science:	2 courses	2
	3 courses	8
	4 courses	2

* No requirements--1 state; 1 course--2 states; 5 courses in science or math--3 states; Requirements by local policy--5 states.

** No requirements--1 state; 5 courses in science or math--3 states; Requirements by local policy--5 states.

STATE POLICIES AND GUIDELINES

Teacher Certification: Minimum Requirements for Elementary Certification (N=54)

Science	Number of States	Mathematics	Number of States
3-4 credits	4	2-4 credits	4
5-6	8	5-6	13
7-12	8	7-12	4
Set by institution	4	Set by institution	4
Combined science/math	6	Combined science/math	6
Other*	9	Other*	9
No minimum requirements	15	No minimum requirements	14

Teaching Methods for Elem. Sci/Math	Number of States	Supervised Teaching Experience	Number of States
Science & Math methods	19	5-6 credits	17
Science only	3	8-9	5
Math only	3	12	1
Set by institution	2	Set by institution	3
Other**	2	300 - 520 hours	4
No requirement	25	9 - 10 weeks	2
		12 weeks	2
		Other***	12
		No requirement	8

* Determined by approved/competency-based program--4 states; 10 quarter hours (45 for grades 4-8)--1 state; 9 quarter hours--1 state; 18 quarter hours--1 state; 2 courses science, 1 math--1 state; 1 course--1 state.

** Part of program, not required--1 state; Competency-based--1 state

*** 3 credits science, 5 credits math--1 state; 1 quarter--1 state; 1 semester full-time or 2 semesters half-time--1 state; 15 quarter credits--2 states; 8 quarter credits--1 state; 1 course--1 state; 1 semester practice teaching or 1 year classroom experience--1 state; 30 semester hours and clinical experience--1 state.

STATE POLICIES AND GUIDELINES

Teacher Certification: Minimum Requirements for Secondary Certification in Science or Mathematics (N=54)

Mathematics	Number of States	Science: Broad-field Certification	Number of States
12-16 credits	1	18-24 credits	6
18-21	10	30-36	13
24	12	40-48	6
27-34	13	51-60	4
36-45	4	Set by institution	5
Set by institution	5	Other*	9
Other*	8	No specific certif.	10
No minimum requirement	1	No requirement	1

Science	Number of States		
	Biol, Chem, or Physics	Earth Sciences	General Science
12-16 credits	4	3	2
18-21	6	6	6
24	10	10	4
27-34	10	8	10
36-45	7	6	8
Set by institution	5	5	5
Other*	9	9	9
No specific certification	2	6	9
No minimum requirement	1	1	1

Teaching Methods for Secondary Sci/Math	Number of States	Supervised Teaching Experience	Number of States
Science & Math methods	24	5-6 credits	20
Science only	2	8-9	7
Math only	3	12-15	2
Set by institution	5	300-450 hours	3
Competency-based	1	9-12 weeks	4
No requirement	19	Set by institution	4
		Other**	10
		No requirement	4

* Major in field--2 states; 20-40% of program--2 states; Courses matched with job requirements--1 state; 60 quarter credits for broad-field science, 30 in other fields--1 state; 45 qtr. hrs. math, 75 broad-field science, 40 specific science fields--1 state; 36 qtr. hrs. math, 48 broad-field science, 24 specific fields--1 state; Not avail.--1 state.

** See footnote 3, page 11.

STATE POLICIES AND GUIDELINES

Teaching Certification: Minimum Requirements for Middle School/ Junior High Certification (N=54)

Science	Number of States	Mathematics	Number of States
12-16 credits	3	12-16 credits	5
18-21	8	18-21	8
24	1	24	3
30-36	5	27	1
Set by institution	5	Set by institution	5
Other*	2	Other*	2
No specific requirement	2	No specific requirement	2
No specific certification	28	No specific certification	28

Teaching Methods for Mid/Jr. High Sci/Math	Number of States	Supervised Teaching Experience	Number of States
Science & Math methods	9	5-6 credits	5
Science only	1	9-12	2
Set by institution	3	Set by institution	3
Other*	2	300 -400 hours	3
No requirement	11	9 - 12 weeks	3
No specific certification	28	Other**	10
		No specific certification	28

Other Policies or Guidelines	Number of States (N=54)
Alternative certification program to increase number of science/math teachers	24
Continuing education requirements for recertification	38
Mandate or funds for staff development or inservice targeted for science/math teachers	26

* 10 quarter hours in math, 45 hours science--1 state; Courses matched with job requirements--1 state.

** Elementary or secondary experience qualifies--4 states; 1 course--1 state; 1 semester practice teaching or 1 year classroom experience--2 states; 15 quarter hours--1 state; Not specified--1 state; Courses matched with job requirements--1 state.